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this star as deduced from a series of observations taken in 1851–4. Another pretty extensive series has now been completed with a result as near to the former as could be expected. The observations are not quite so closely accordant as in the first series, the weather having been somewhat less favourable, and the observer from the state of his health not being in quite so good practice, yet the course of the parallactic curve at different seasons of the year is traced out nearly as well as before.

"A discussion of the angles of position gives for the value of the constant of parallax, $x = + 0''{\cdot}0692 \pm 0{\cdot}0080$. A similar discussion of the distances gives $x = + 0''{\cdot}031 \pm 0{\cdot}0136$. Combining the two values of x, according to their weights the definitive value is $x = + 0''{\cdot}0616 \pm 0{\cdot}0075$, a result almost identical with that obtained in 1853."

RECENT PUBLICATIONS.

Zeitschrift für populäre Mitheilungen aus dem Gebiete der Astronomie und verwandter Wissenschaften, Herausgegeben von Professor C. A. F. Peters, Director der Sternwarte in Altona. Band i. Heft i. Altona, 1858.

The Editor states, in a short preface, that this periodical, which may be considered as a continuation of Schumacher's *Jahrbuch*, is to be devoted to essays on astronomical and physical subjects. The present number contains a paper by Professor Quetelet on the Periodical Appearances of Planets, and a paper by Professor Hansteen on Terrestrial Magnetism.

Annales de l'Observatoire Impérial de Paris. Par U. J. Le Verrier, Directeur de l'Observatoire. Tome troisième. Paris, 1857.

The first two volumes of this important publication have been already noticed in the Annual Report of the Council for 1857. The present volume commences with M. Villarceau's valuable researches on the problem for determining the orbit of a planet or comet, a brief account of which was given in the *Monthly Notices* for last November. The remaining part of the volume is devoted to a continuation of M. Le Verrier's astronomical researches, as given in the first and second volumes. We find in it a thorough investigation of the theory of the periodic comet of 1770, an exposition of the principles relative to the construction of tables of the movements of the planets, the formation of ephemerides, and the comparison of theory with

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observation. There are two appendices to the volume, containing the transits of fundamental stars observed at Greenwich between 1750 and 1830, and at Königsberg between 1814 and 1830, with the resulting clock-errors.

Verhandelingen der Koninklijke Akademie van Wetenschappen. Tweede Deel. Amsterdam, 1855.

This volume contains a paper by Dr. Oudemans, in which he determines the orbit of D'Arrest's Comet, by a discussion of the totality of the observations made on the occasion of its passage of the perihelion in 1851.

Uber die Existenz eines widerstehenden Mittels im Weltraume. Von J. F. Encke, Director der Berliner Sternwarte. Berlin, 1858.

This is a separate publication of a paper which appears in the Berlin *Jahrbuch* for 1861. In a short introduction, Professor Encke gives a general explanation of its nature and of the circumstances which gave rise to his researches on the existence of a resisting medium. Upon his discovery, in 1819, of the periodicity of the comet which bears his name, he expressed his opinion that the time of revolution was gradually becoming shorter. The twelve perihelion passages of the comet which have since elapsed have served to confirm this conjecture. In every instance the return of the comet has been calculated beforehand upon the supposition of the existence of a resisting medium, without which its rediscovery, except perhaps on three occasions, would not have been effected. The author, accordingly, does not entertain the slightest doubt respecting the legitimacy of his hypothesis. His researches on the subject are mainly contained in the volumes of the Berlin Academy of Sciences for 1829, 1831, 1833, 1836, 1842, 1844, 1851, and 1854. Abstracts of these papers are to be found in various numbers of the *Astronomische Nachrichten.* In Nos. 210–11 (Vol. IX.), of that periodical there appears an original paper on the subject. The volumes of the Berlin *Jahrbuch* for 1822 and 1823 also contain some results of Professor Encke's earlier labours on the motion of the comet considered with reference to a resisting medium.

The paper now before us is divided into seven sections, in which the existence of a gradual diminution of the time of revolution of the comet is proved,—

1st. From the close agreement of the observations of the comet with the results of calculations executed beforehand on the supposition of a resisting medium.

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2d. From researches on the observations of 1819–38.

3rd. From researches on the observations of 1819–48, and the agreement of the results with those of 1819–38.

4th. From the impossibility of representing the motion of the comet during the period 1819–48 by the existing theory of gravitation.

5th. From the close agreement of the observations previous to 1819, and subsequent to 1848, with the results derived from 1819–48.

6th. From an examination of the observed perihelion passages and the corresponding results freed from planetary perturbation.

In the seventh and last section Professor Encke briefly explains the reasons by which he has been led to account for the anomaly in the comet's motion by the hypothesis of a resisting medium.

The author finally remarks in the introduction to his paper that no new calculations have been considered necessary on the present occasion. All the numerical values employed have been already given in the memoirs above referred to. Only a few results relating to the two last perihelion passages of 1855 and 1858 have been added to them.

§ 1. It has been stated that, soon after his discovery of the periodicity of the comet in 1819, Professor Encke, upon comparing the perihelion passage of that year with the earlier perihelion passages of 1805, 1795, and 1786, discovered that the time of revolution, when freed from the effects of planetary perturbation, was gradually becoming shorter.—(Berlin *Jahrbuch*, 1822, p. 200; 1823, p. 215). After the rediscovery of the comet in 1822, the perihelion passages for 1825 and 1828 were calculated on the supposition of a resisting medium; and in Nos. 210–11 of the *Astronomische Nachrichten*, the author has given a complete investigation of the subject, and has supplied the arguments and formulæ to which he has since invariably adhered. In that paper Professor Encke supposes the resistance offered by the medium to be proportional to its density and to the square of the velocity of the moving body: he moreover supposes the density of the medium to vary inversely as the square of the distance from the sun. He accordingly expresses the action of the resisting medium upon the comet by the following tangential force:—

$$U' = U \, . \, k^2 \left(\frac{2}{r} - \frac{1}{a}\right) . \, \frac{1}{r^2}$$

U being a constant depending on the resistance, k the Gaussian constant of the *Theoria Motus*, a the mean distance of the comet, and r the radius vector.

Professor Encke collects together all the results relative to the times of perihelion passage which have been observed during the 72 years comprised between 1786 and 1858, and he

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proposes the problem to account for the motion of the comet during that period. Previous to 1819 the effects of planetary perturbation are only approximately calculated. During the period 1819–48 these effects are rigorously taken into account. In regard to the remaining period 1848–58, the minor planets occupied so much of the calculating force of the observatory that Professor Encke could only take into consideration the influence of *Jupiter*, which exercises by far the most powerful disturbance on the motion of the comet.

In consequence of the calculations which have been made beforehand on the occasion of each successive return of the comet to the perihelion, subsequently to the year 1819, no return of the comet has since been allowed to pass unobserved. In every one of such instances the hypothesis of a resisting medium has been introduced into the calculations. The following are the differences between the observed and calculated geocentric places of the comet at the time of its rediscovery on the occasion of each return to the perihelion:

	′		′		′		′
1822	2·0	1832	2·2	1842	0·9	1852	0·5
1825	2·3	1835	1·3	1845	0·8	1855	8·2
1828	3·0	1838	2·0	1848	3·7	1858	0·5

The large error for 1855 occurs in a year for which the perturbations are only approximately given. There occurs also a slight error in the calculation for that year.

The author here remarks that since the time of the comet's perihelion passage, setting out from the year 1819, occurs earlier on each successive occasion than it ought to do according to the existing theory of planetary motion, and that to the extent of

0·5 days in 1838
2·0 „ 1848
4·5 „ 1858

So there lies in the agreement between the observed places of the comet and the corresponding places calculated beforehand on the hypothesis of a resisting medium, the strongest indirect proof which could be desired in favour of such an hypothesis. In the year 1858 the error of 4·5 days in the time of the perihelion passage would have caused an error of 3°·4 in the geocentric place of the comet. "It has not been possible," says the author, "to institute a similar comparison with respect to any other periodic comet. Astronomers have satisfied themselves with merely assigning the place in general where the comet was to be sought for, and have contented themselves with a rough approximation. A similar investigation undertaken with respect to the other periodic comets is much to be desired. Each of such investigations would have its peculiar difficulties, arising from the circumstance of the time of revolution being longer than in the present case, and consequently there being fewer observed passages of the perihelion."

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In the second section the author investigates the motion of the comet for the period 1819–1838, comprising seven revolutions. The perturbations are computed in both directions from the perihelion passage of 1822, (Jan. 9·72). Normal places are obtained by means of the observations, and 52 equations of condition are formed, involving eight unknown quantities, viz. the corrections to the six elliptic elements, a correction to the mass of *Mercury*, and a correction to the quantity U (approximately assumed in the first instance) depending on the action of the resisting medium. The treatment of these equations by the method of least squares gives new values of the mass of *Mercury* and of U, with which the perturbations of the mean motion and mean anomaly are computed afresh for each perihelion passage. With the resulting values of these elements and the values of the other elements previously deduced, the places of the comet are calculated for the instants corresponding to the normal places furnished by the observations; and in this manner a comparison is instituted between the calculated and observed places. The mean value of the residual errors is $19''\cdot92$. Upon this point the author makes the following remarks:—

"This mean error is certainly greater than what we should be justified in expecting from the excellence of the greater number of the observations. Its magnitude, however, mainly depends on the uncertainty affecting the observations after the perihelion passages of 1822 and 1832. If we reflect further that the motion of the comet is represented during a period of twenty years, in the course of which it is difficult to ascertain, in consequence of the imperfectly defined outline of the body, whether the same point had been assumed for the centre of gravity on the occasion of each of the seven returns to the perihelion, the result of the comparison between theory and observation must be regarded as very satisfactory. Moreover, if we take into consideration the circumstance that in order to obtain this degree of accordance it has been found necessary to apply to the mean anomaly a correction depending upon U, proportional to the square of the time, and amounting to $540''$ for the period 1819–38, a correction which is altogether foreign to the theory of elliptic motion, and in some instances produces a displacement of $2\frac{1}{2}^\circ$ in the geocentric place of the comet, we hereby obtain a direct proof that the hypothesis in its general form is necessary throughout."

In the third section Professor Encke exhibits the results of a similar investigation of the motion of the comet, founded on the observations made during the period 1819–48, comprising ten perihelion passages. The definitive values of the elements agree closely with those derived from the previous investigation. The mean value of the residual errors amounts to $26''\cdot02$. If the observation of 1842 May 18·63 be excluded the mean error amounts to $22''\cdot73$.

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In the fourth section the author shows that if the expression for U be excluded from the investigation, nearly the same results will be obtained for the period 1819–48, if a system of elements be used in which the mean motion varies in the direct proportion of the time, and the mean anomaly in the proportion of the square of the time. He proves that it is utterly impossible to represent the motion of the comet by a system of elements in which the purely elliptic values of the latter elements are employed. In the fifth section the observations previous to 1819 and subsequent to 1848, are compared with the theoretical results founded on the researches for the period 1819–48 and satisfactory results are obtained.

In the sixth section the author institutes some interesting comparisons illustrative of the gradual shortening of the time of revolution of the comet, and the adequacy of his theory to account for the result. We extract the following table:—

	$\tau_n - \Delta\tau_n$	Diff.	αt^2	Regular Periods.
1786	−15747·66		+ 9·46	−15738·20
		1212·79		
{1789}	−14534·87		8·06	−14526·81
		1212·67		
{1792}	−13322·20		6·77	−13315·43
		1212·55		
1795	−12109·65		5·59	−12104·06
		1212·44		
{1799}	−10897·21		4·53	−10892·68
		1212·33		
{1802}	− 9684·88		3·58	− 9681·30
		1212·22		
1805	− 8472·66		2·74	− 8469·92
		1212·10		
{1809}	− 7260·56		2·01	− 7258·55
		1212·00		
{1812}	− 6048·56		1·40	− 6047·16
		1211·89		
{1815}	− 4836·67		0·89	− 4835·78
		1211·78		
1819	− 3624·89		0·50	− 3624·39
		1211·66		
1822	− 2413·23		0·22	− 2413·01
		1211·55		
1825	− 1201·68		0·06	− 1201·62
		1211·44		
1829	+ 9·76		0·00	+ 9·76
		1211·32		
1832	+ 1221·08		0·06	+ 1221·14
		1211·22		
1835	+ 2432·30		0·22	+ 2432·52
		1211·11		
1838	+ 3643·41		0·50	+ 3643·91
		1210·98		
1842	+ 4854·39		0·89	+ 4855·28
		1210·88		
1845	+ 6065·27		1·40	+ 6066·67
		1210·77		
1848	+ 7276·04		2·01	+ 7278·05
		1210·65		
1852	+ 8486·69		2·74	+ 8489·43
		1210·55		
1855	+ 9697·24		3·57	+ 9700·81
		1210·44		
1858	+10907·68		+4·52	+10912·20

The second column of the foregoing table exhibits the number of days, less the effects of planetary perturbation, included between the various observed passages of the perihelion extending from 1786 to 1858, and the perihelion passage of 1829. The third column exhibits the differences of those

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numbers, which would be constantly of the same value and equal to the time of revolution of the comet if its motion was solely dependent on the force of gravitation. The fourth column contains the numbers, with reversed signs, depending on the square of the time, which the author has deduced from the hypothesis of a resisting medium. These numbers, when applied to those in the second column, give the numbers in the fourth column, which exhibit a series of intervals regularly increasing in each direction from the perihelion passage of 1829, conformably to the principles of elliptic motion. It is plain, therefore, that in the present state of the observations of the comet, the term αt^2 suffices to account for the anomaly in its motion. It ought to be remarked that slight corrections have been applied to the perihelion passages previous to 1819 and subsequent to 1848, in consequence of the imperfect computation of the perturbations for those periods. The perihelion passages included between the intervals 1786–95, 1795–1805, and 1805–19, were not observed.

In the seventh and last section of his investigation Professor Encke states the reasons by which he was led to account for the anomaly in the comet's motion by the hypothesis of a resisting medium. The probability of the existence of such a medium was supported by the authority of Newton, who merely assumed its non-existence on the ground of its not exercising any sensible influence on the motions of the planets. It is not surprising, however, that such should be the observed result when we take into consideration the condensed masses of the planets on the one hand, and on the other the loose structure of the comet, which exhibits no trace of a determinate nucleus. But what appeared to Professor Encke to constitute the most powerful argument in favour of a resisting medium was this,—the anomaly appeared to consist solely in a gradual increase of the mean motion of the comet, which was explicable by a force continually acting in the direction of a tangent to the orbit; and this again was in exact accordance with the effect which would be produced by a resisting medium. As regards other explanations which had been offered, the effects were of a periodical nature, and, therefore, could not account for the phenomena in the present instance.

ERRATA.

Vol. XIX., No. 1, page 1, line 1, *for* Jackson, *read* Graham.
— — — 2, *for* Nicholl, *read* Nichol.
— — 18, line 7 from the bottom. The sentence beginning with "To the naked eye," &c., and ending with "*Ursa Major*," should have been attached to the observations of Oct. 5 instead of those of Oct. 2.